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SISSA
Scuola Internazionale Superiore di Studi Avanzati

Unveiling Earth's Critical Resources for Clean Energy and a sustainable Future (EarthSafe)

HORIZON-MSCA-2022-DN-01-01 - MSCA Doctoral Networks 2022

JOBS INFORMATION

Host Organisation	Scuola Internazionale Superiore di Studi Avanzati
Department	Mathematics Area, PhD course in Mathematical Analysis, Modelling, and Applications
Country	Italy
Application Deadline	5th December 2023 – 13.00 hrs
Type of Contract	Temporary
Job duration	36 months
Job Status	Full-time
Offer Starting Date	March 1st 2024
Is the job funded through the EU Research Framework Programme?	HE/MSCA
Marie Curie Grant Agreement Number	101120556

Position 5
Validation, Verification and Uncertainty Quantification of the computational model of crustal flows

Supervisory Team	Primary academic institution: Prof. Gianluigi Rozza (SISSA) Associated advisory team: Prof. P. Diez (Universitat Politècnica de Catalunya)

Project Description

Modelling of crustal flows requires high-performance computing infrastructures together with advanced numerical techniques, like Reduced Order Models (ROMs), in order to perform the simulations in a reasonable amount of computational time. At the same time, in order for the results of the numerical experiments to be applicable to real-world decision-making, errors and uncertainties of the model outcomes should be evaluated using Validation, Verification, and Uncertainty Quantification (VVUQ). However, standard methods of VVUW bring an even higher burden on the computational resources. Moreover, the representation of the problem on a variety of temporal and spatial scales makes the task even a bigger challenge. Hence, the development of advanced techniques is required in order to obtain accurate error and uncertainty estimates in an effective way. The goal of this project is to study the error and uncertainty sources to set the VVUQ problem and to examine the numerical definition of the model as well as its multiscale properties combined with the opportunities provided by the ROMs to design an effective approach for VVUQ of crustal flow models.

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The successful candidate will collaborate closely with researchers at SISSA (Italy), as well as with partner UPC (Barcelona) and other members of EarthSafe. This project is relevant to a number of other EarthSafe projects (e.g. 1, 2 and 6).

Position 6
Development of novel Reduced Order Models for the efficient numerical simulation of crustal flows

Supervisory Team Primary academic institution: Prof. Gianluigi Rozza (SISSA)
Associated advisory team:
Prof. J.C. Afonso (University of Twente)
Prof. J. van Hunen (Durham University)

Project description
Within processes involving geodynamic and geological phenomena, such as fluid circulation in porous media and lower crust flow (referring to lower crust, magmatic crustal inflation, and delamination of mantle lithosphere for instances), Stokes equations represent one of the most used mathematical frameworks at the aim to model and describe such systems they being characterised by flows at low Reynolds numbers. Another peculiarity is represented by their non-Newtonian behaviour resulting in non-linear constitutive relationships between stress and deformation. The analysis of such phenomena could be affected by computationally-expensive numerical simulations. Although the development of high-performance computing (HPC) infrastructures in recent years has allowed us to adopt numerical tools within the crustal flows context, at the moment only simplified cases can be addressed. So there is the need to make more efficient the computational framework at the aim to deal with more realistic applications.
In such a scenario, Reduced Order Models (ROMs) could be proposed as a useful tool to accelerate the computations without a significant loss of accuracy. This work will draw on recent research lines developed by the Supervisory Institution (SISSA mathLab) in the ROM context with the aim to reach and overcome the current state of the art. Most of the current ROMs are based on intrusive methods which, despite being very accurate, significantly limit the performance in terms of computational cost. The goal of this project is to develop a ROM in the context of real-world crustal flows applications based on novel hybrid and data-driven, even machine learning based, approaches able to provide an optimal balance between accuracy and efficiency. The successful candidate will collaborate closely with researchers at SISSA (Italy), as well as with partners University of Twente and Durham University.

REQUIREMENTS (for both projects)

Education Level Master of Science degree or equivalent in Engineering,

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	Physics, Computer Sciences, Mathematics or similar
Skills/Qualifications	Demonstrable knowledge in computer programming with either Fortran, Matlab, Python and/or C; Experience with Numerical Methods for Partial Differential Equations; Excellent level of spoken and written English; Demonstrable experience writing scientific articles/reports;

ADDITIONAL INFORMATION
Working place, supervisor, and secondments

The projectS will be carried on under the supervision of Prof. Gianluigi Rozza, within the Mathematical Analysis, Modelling, and Applications group at SISSA - Scuola Internazionale Superiore di Studi Avanzati, located in Trieste, Italy. SISSA is a scientific center of excellence within the national and international academic scene, with focus on three main areas: Physics, Mathematics and Neuroscience. SISSA features 100 professors and researchers, about 100 post-docs, 300 Ph.D. students and 115 technical administrative staff members. SISSA offers top facilities for research, such as High-Performance Computing. SISSA has leading roles in large international collaborations and, constitutes a research network with the other scientific institutions in the area, including the International Centre for Theoretical Physics (ICTP). SISSA has also drawn up several collaboration agreements with the world's leading schools and research institutes. SISSA holds the top position among Italian scientific institutes in terms of research grants obtained in relation to the number of researchers and professors. The SISSA Valorisation Office will provide support for talent enhancement, career development, and offer training on best practices for dissemination and public outreach.

The Mathematical Analysis, Modelling, and Applications group has been one of the first to be established in SISSA, and has awarded more than 220 Ph.D. titles in more than 40 years. The group comprises 15 staff members, 15 postdocs and 38 Ph.D. students.
The activity in mathematical analysis is mainly focused on Dynamical Systems and PDEs, on the Calculus of Variations, on Hyperbolic Conservation Laws and Transport Problems, on Geometric Analysis and on Geometry and Control theory. Connections of these topics with differential geometry and reduced order modelling are also developed.
The activity in mathematical modelling is oriented to subjects for which the main technical tools come from mathematical analysis. The present themes are multiscale analysis, mechanics of materials, micromagnetics, modelling of biological systems, computational fluid and solid dynamics, numerical analysis and scientific computing, and problems related to control theory.
The applications of mathematics developed in this course are related to the

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numerical analysis of partial differential equations and of control problems. This activity is developed in collaboration with MathLab group for the study of problems coming from the real world, industrial and medical applications, and complex systems.
Gianluigi Rozza is professor in Numerical Analysis and Scientific computing at SISSA. Phd in Applied Mathematics at EPFL in 2005, MSc in Aerospace Engineering at Politecnico di Milano in 2002, post-doc at MIT. At SISSA he is the coordinator of SISSA Mathematics Area, lecturer in the master in High Performance Computing, in the master degree in Mathematics with the University of Trieste, and in the master degree in data science and scientific computing. He is SISSA Director's delegate for Valorisation, Innovation, Technology Transfer and Industrial Cooperation. His research is mostly focused in numerical analysis and scientific computing, developing reduced order methods. Author of more than 130 scientific publications (editor of six books and author of two books). Co-advisor of 30 master thesis, co-director/director of 20 PhD theses since 2009. Principal Investigator of the European Research Council Consolidator Grant (H2020) AROMA-CFD and PoC ARGOS (HE), as well as for the project FARE-AROMA-CFD funded by Italian Government. Within SISSA MathLab he is responsible of several industrial projects with companies such as Danieli, Electrolux, Wartsila and Fincantieri. He is member of the Applied Mathematics Committee of European Mathematical Society.
More:http://people.sissa.it/grozza

Eligibility criteria
Applicants can be of any nationality and must hold a Master of Science degree (or equivalent) in a scientific subject, relevant to the aforementioned topics. They need to fully respect the following eligibility criteria:
(a) Must be doctoral candidates, i.e., not already in possession of a doctoral degree at the date of the recruitment.
(b) Must undertake transnational mobility. Researchers must not have resided or carried out their main activity (work, studies, etc.) in Italy for more than 12 months within the 36 months immediately before their date of recruitment. Compulsory national service, short stays such as holidays, and time spent as part of a procedure for obtaining refugee status under the Geneva Convention are not taken into account.

A good knowledge of spoken and written English is required and will be evaluated during the selection process.

How to apply

Candidates should apply through https://pica.cineca.it/sissa/ by 5th December 2023 – 13.00 hrs. CEST – to one or both positions and should provide:
- An application form duly completed.
- A Curriculum Vitae (CV) including previous technical and scientific

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experiences with a list of publications (if any) and/or participation to scientific meetings and research expertise.
- Motivation letter, including research interests and the reasons for applying for this programme;
- Undergraduate level certificates, including university grades and the detailed list of university courses with grades. Copies of any other scientific publication that the candidate believes significant are also welcome.
- The applicant must also provide two reference letters.

Evaluation and interview

The selection process will consist of two different selection phases and will be based on:

1. Academic qualifications
2. Interview

After the first selection phase, based on the CVs and qualifications, only candidates with a minimum mark of 21/30 will be contacted to attend the interview. Candidates will be interviewed by a committee that includes at least two EarthSafe members. The interview, aiming to assess the skills, the motivation and the fluency in English, will take place in SISSA or in remote between **11 and 15 December**. **The interview minimum mark to be considered eligible will be 49/70.**
The first candidate in the ranking list (Academic qualifications + Interview) will be offered the position. If, for any reason, the selected candidate should decline the offer or will fail to comply with the requirements for taking up the position, the next in the classification list will be offered the position.

At SISSA, we value diversity and equality. SISSA recognizes that employees may wish to have working patterns that fit with their caring responsibilities or work-life balance. Due consideration will also be given to applicants who have had career breaks for reasons including maternity, paternity or adoption leave, disability or illness.

Rights and responsibilities of researchers participating in Marie Sklodowska-Curie Actions

The European Charter for Researchers is a set of general principles and requirements which specify the roles, responsibilities and entitlements of both researchers and the employers and/or funders of researchers. The aim of the Charter is to ensure that the nature of the relationship between researchers and employers or funders is conducive to successful performance in generating, transferring, sharing and disseminating knowledge and technological development and to the career development of the researchers.

It is mandatory for applicants to read and understand the detailed information regarding the rights and responsibilities of researchers engaged in a Marie Sklodowska-Curie Innovative Training Network. The European Charter for researchers can be accessed at

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https://euraxess.ec.europa.eu/jobs/charter/code

Employment contract and remuneration
The selected candidate will receive a salary in accordance with the MSCA regulations for DCs. The gross salary includes a living allowance (approx. € 3400,00 gross per month subject to MSCA Country Correction Coefficient) a mobility allowance (approx. € 600,00 gross per month) and a family allowance where 'Family' means persons linked to the researcher by (i) marriage or (ii) a relationship with equivalent status to a marriage recognized by the legislation of the country where this relationship was formalized or (iii) dependent children who are actually being maintained by the researcher).
The guaranteed (EC) funding is for 36 months.

Personal Data
Any personal data will be processed in accordance with the General Data Protection Regulation 679/2016 EU (GDPR) on the Protection of Individuals.

For information: EarthSafe Project Webpage

Email: phd@sissa.it

The Director
(Prof. Andrea Romanino)
(digitally signed)

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